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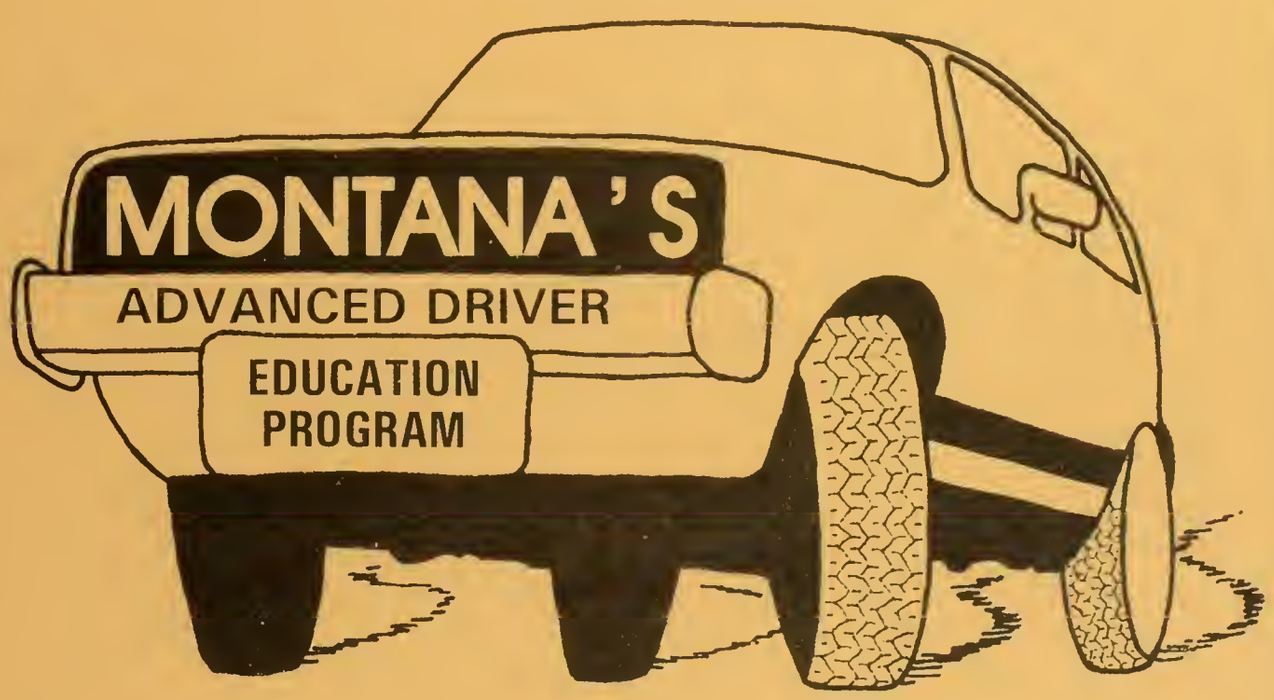
Montana's Advanced Driver Education Program

A Training Manual for Driver Educators



Montana Office of Public Instruction
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Acknowledgement

This publication, **Montana's Advanced Driver Education Program: A Training Manual for Driver Educators**, is patterned after publications developed by the General Motors Proving Grounds staff and copyrighted by GMC. We especially acknowledge the work of ''Doc'' Whitworth, Manager, Traffic Safety, Planning and Training, General Motors Proving Grounds, Milford, Michigan 48042. ''Doc'' has been and continues to be a wise and trusted counselor who has contributed significantly to the success of Montana's Advanced Driving Program.

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Curt Hahn, Manager
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Office of Public Instruction

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Foreword

The Montana Office of Public Instruction has been involved with driver education for many years. One of our major objectives has been to provide the finest statewide traffic education programs possible. Experience has shown that even the most competent and careful driver may eventually have to face an emergency situation on the road where correct judgment and quick response prevent a collision.

Unfortunately, few drivers have had a chance to practice the techniques required to handle these critical emergency situations. The purpose of this Advanced Driver Education Program is to provide drivers with this type of practice. Through a series of planned exercises and experiences, drivers are taught to respond quickly and correctly to a variety of common driving emergencies.

The program described in this manual is designed for presentation to a variety of highway safety personnel, such as teachers of driver education, ambulance drivers, school bus drivers, and law enforcement personnel. However, the teaching of the techniques described herein should be used only by a person who has completed the Montana Advanced Driver Education Program or its equivalent.

Ed Argenbright
Superintendent of Public Instruction

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I. Driver Preparation

SEAT ADJUSTMENT

Proper seat adjustment is related to the driver's ability to control a vehicle. You should be comfortable while driving in order to avoid fatigue and allow yourself maximum freedom to maneuver the vehicle with ease.

Position the seat as far back as leg length will allow and still be able to operate the foot controls. In this position, thighs should be resting on the seat and the knees should be slightly flexed. Adjust the seat until this position is achieved and make sure the seat is locked. Now, check your position by placing your hands at 9 and 3 o'clock on the steering wheel. You should not feel cramped. To be able to steer quickly, it is important that your arms be away from the body and slightly flexed at the elbow (Figure 1). Sizes and shapes of people vary greatly. As a result, the optimum seating position may have to be modified to meet individual requirements.

HAND POSITION

Place your hands as near to 9 and 3 o'clock on the steering wheel as possible (Figure 2). This balanced hand position will enable you to turn the steering wheel 180 degrees in either direction very quickly. Should it be necessary to turn more, the hand-over-hand method of steering should be used. The transition from the 9-3 position to hand-over-hand method of steering should be used. Going from the 9-3 position to hand-over-hand should be executed when the grip is naturally released as the wheel is turned. An unbalanced hand position, such as 10 and 2 o'clock, restricts your initial steering ability and may cause you to pull the steering wheel to one side as the motion of the vehicle tends to push your body in one direction or another. This unwanted steering may cause the vehicle to go some place other than where you want it.

It is important to remember that a given emergency may require more than the 180 degrees of steering that can be accomplished by the 9-3 hand position. Skid control is a good example. When more steering control is needed, the driver should progress smoothly to the hand-over-hand technique.

MIRRORS

Mirrors provide visual contact with the traffic situation behind you. Proper mirror adjustment is an important part of a good driving position. While sitting back in the seat, adjust the inside mirror so that it highlights the rear of your vehicle and you can see several hundred feet behind it (Figure 3).

Adjust the outside mirror so that from the same seating position you can see several hundred feet to the rear using the left edge of your vehicle as a reference point (Figure 4). Turn it out so there is as little as possible of your vehicle showing in it—just enough so you will know where other vehicles are relative to your own. The more the outside mirror is turned away from the vehicle, the greater the field of view to the left and rear. Mirrors set in this manner will allow you to better see traffic conditions behind you at a glance. The practice of glancing right or left when making a lane change is still advised.

INSTRUMENT PANEL

The last element of good driving position is total familiarity with the instrument panel. You should have a mental picture of where every control is located on the dash. This will enable you to reach any control, such as the wiper switch, without taking your eyes off the road.

VISUAL PERCEPTION CONCEPTS

The latest concept of safe highway driving is fourfold: identify, predict, decide, and execute. The first two of these, identify and predict, are critical to collision avoidance. By equipping drivers with the visual perception skills necessary for the identification and prediction of clues in the highway environment, driving performance can be improved. In any traffic situation, and especially an intersection, the vehicle directly ahead should be only one of the clues taken into account. Sufficient following distance must be maintained so that activity around a vehicle can be observed. Also, the driver must scan traffic far enough ahead to be aware of potentially dangerous situations that may develop. Measurements, such as the length of the vehicle, the distance between telephone poles, or even a certain specific number of feet, have been advocated for determining scan and following distance. A much more accurate way to determine these distances is through the use of a measured time span (Figure 4a).

FOLLOWING INTERVAL

The Two-Second interval is a method used to gauge following distance. To understand this timed technique of maintaining a safe following distance, think of your vehicle following another. As the vehicle ahead passes a fixed road mark, (sign poles, a mail box, or shadow) start counting A-thousand-one, A-thousand-two. By the time you complete your Two-Second count, the front of your vehicle should be just passing by the fixed point. If you take less than Two Seconds to reach the checkpoint, you are following too closely to the vehicle ahead. This Two-Second rule for following distance automatically adjusts to any speed. If conditions are bad (fog, rain, poor road conditions), add an extra second or two to the regular Two-Second rule. By making this rule a part of your driving, you are assuring yourself of time and space to safely see, react, and execute a driving maneuver safely. Concentrate on making this technique a habit, and you soon will be establishing a safe following distance automatically.

Figure 1—Proper Driving Position

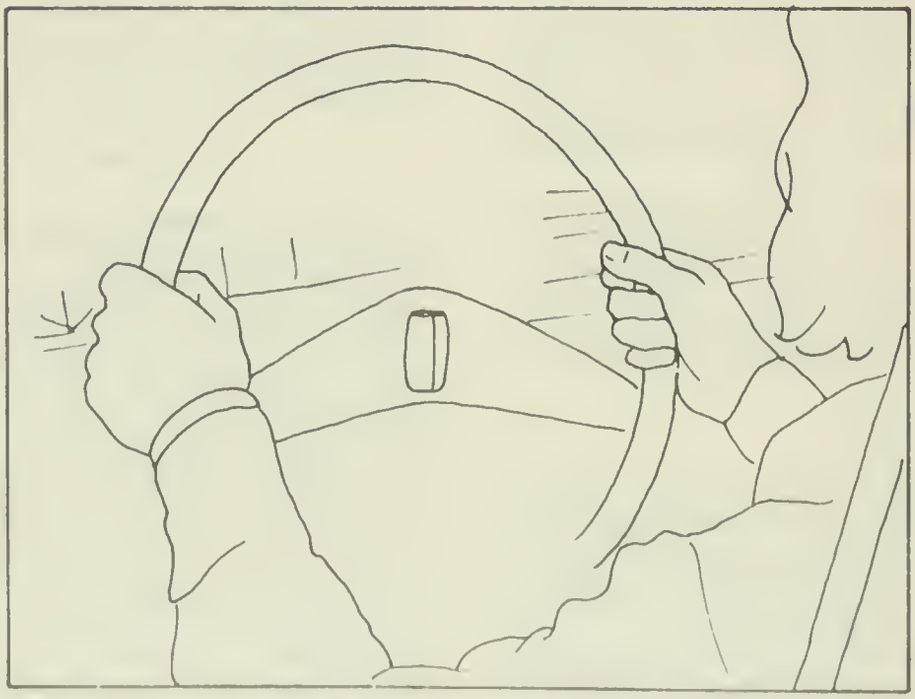


Figure 2—9-3 Hand Position

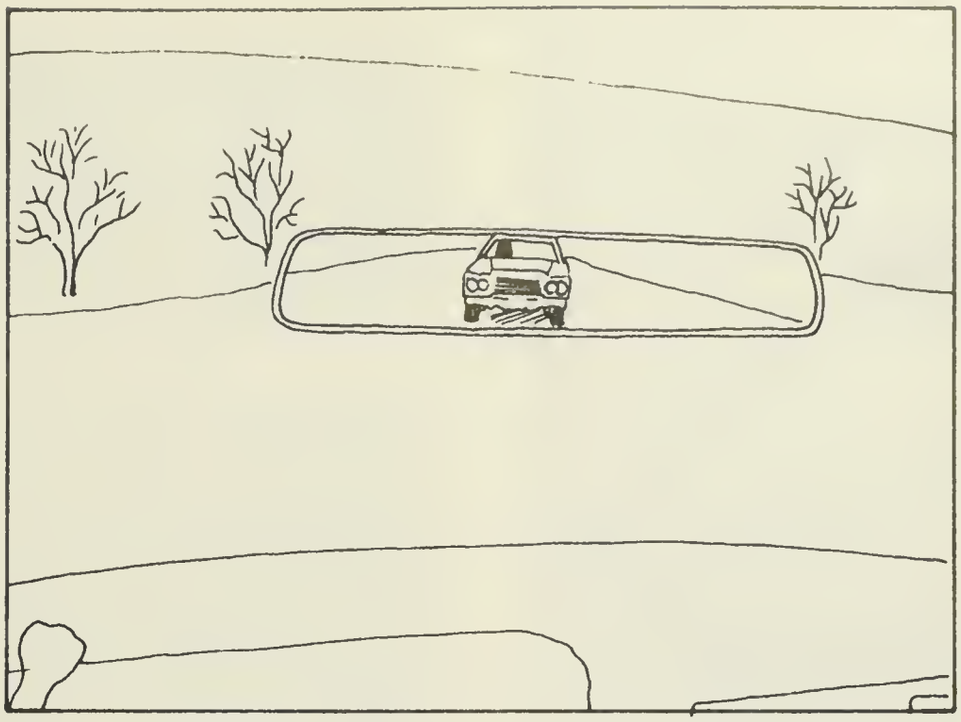


Figure 3—Proper Inside Mirror Adjustment

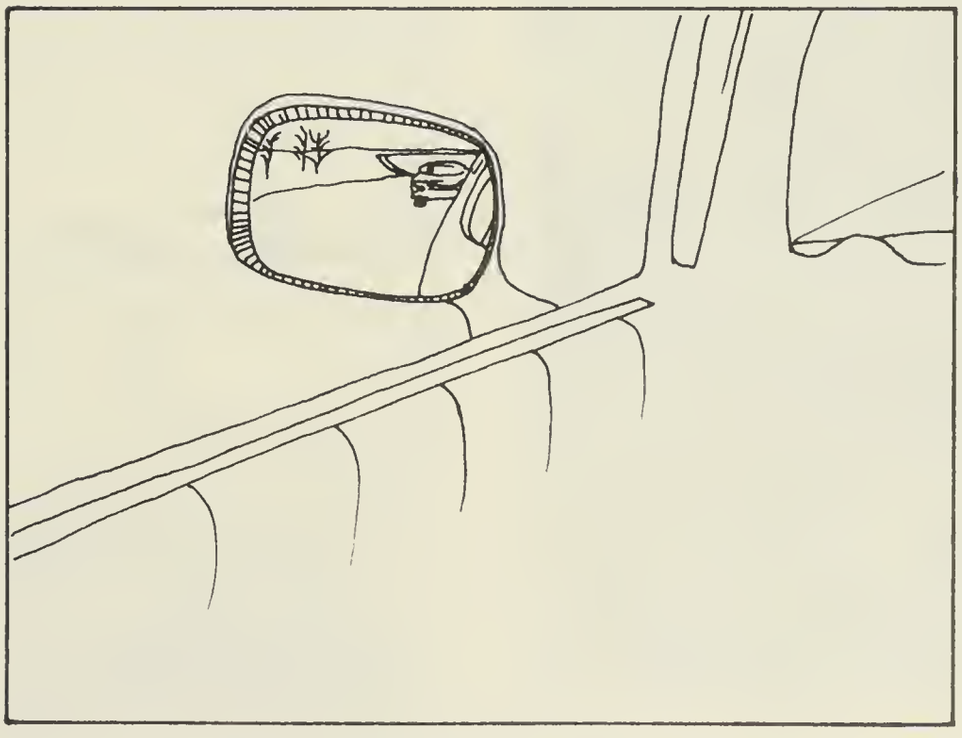


Figure 4—Proper Outside Mirror Adjustment

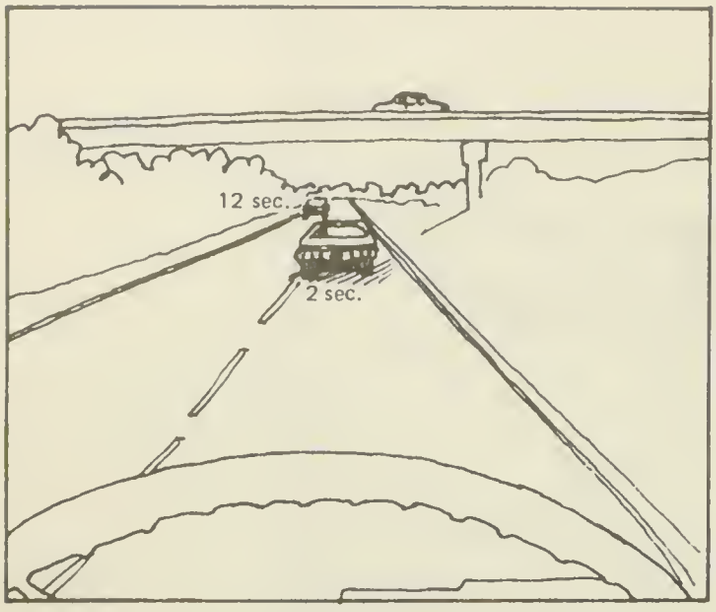


Figure 4a—Two-Second Following and Twelve-Second Forward Scan Distances

FORWARD SCAN DISTANCE

After you have learned to use the Two-Second Principle, you are ready to start working on one of the best visual habits you can develop. Again, pick a fixed point down the road at about the distance you normally concentrate your attention. Pick a point, such as the crest of a hill, a bridge, or bend in the road. By doing this, you can count the time that elapses before you pass that point. Count off the seconds: A-thousand-one, A-thousand-two, etc., that it takes you to travel to the fixed reference point. It should be Twelve Seconds.[1]

You may find that your average point will be from six to eight seconds away. This is the case for the average untrained individual. It takes experience to learn to look Twelve Seconds ahead. Push yourself and you will find that you can exceed this Twelve-Second goal. Again, the Twelve Second rule adjusts to all speeds just as the Two-Second rule does. Obviously, one cannot see Twelve Seconds ahead around a corner, under a bridge, into fog, or in some stop-and-go city driving. There may be other exceptions to the Twelve-Second concept, but think of it as an optimum goal. In both cases of following time and visual lead time, two and twelve seconds may not be exactly right for you. They are good places to start, however, until you can determine what is exactly right for you. The idea is to make two, three, or four seconds of following distance and ten, twelve, or fourteen seconds of visual lead time a HABIT, so that you will be in a position to avoid most traffic conflicts.

It is also important to correct the position of your vehicle within the traffic pattern. Common sense tells you that you can accelerate, brake, and steer to adjust your position. Once you have developed the habit of looking ahead through the use of the Two and Twelve-Second time rules, you will not only see "traps," but will also have more time to adjust lane position, speed, and following distance. This eliminates many of those panic reaction situations by keeping aware of what is happening ahead.

SKILL DEVELOPMENT

Another aid to visual perception is the technique of classification of traffic events. This technique aids the driver in processing all the varied information from the traffic scene. A description of the classification system is appropriate. There are four divisions of events in the traffic scene: **traffic controls, other traffic, highway features,** and **events inside the vehicle.** Traffic controls include all types of signs and roadway markings as well as physical features such as unmarked intersections. Any other animal, vehicle or pedestrian on or near the roadway makes up the "other traffic" classification. Highway features,include the various types of physical roadway features, such as type of pavement, surface, roadway structure (lanes, curves, shapes, etc.), type of intersection and atmospheric conditions. Events inside the vehicle include passengers, control panel indicators, vehicle vibrations and sounds, and glare.[2]

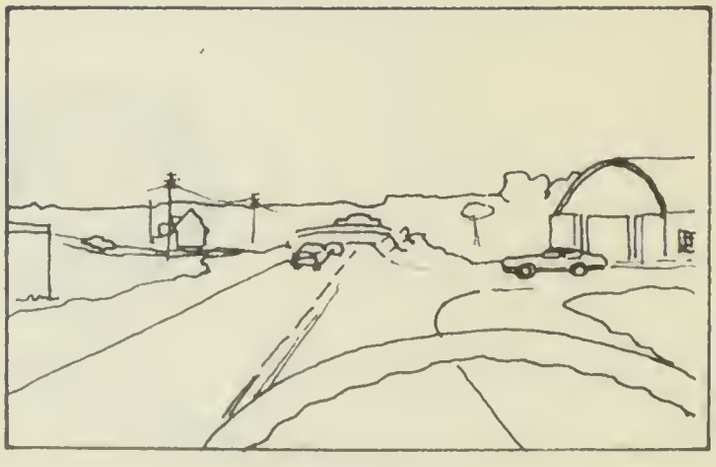


Figure 4b

1. **Traffic Controls: No passing.**
2. **Other Traffic: Vehicle at T intersection, approaching traffic, vehicles at cross intersection.**
3. **Highway Features: Straight, clear and dry surfaces, stop intersection.**
4. **Events Inside Vehicle: None.**

1. "How To Drive," American Automobile Association, 1972, Washington, D.C.

2. Quane, W. Laurance, "**Visual Perception and the Driving Task**," Driver and Public Safety Education Research Digest, 1971

Training in this classification technique has been shown effective and can easily be adapted to a local level. A series of slides containing from one to five "traffic events" should be used in a progressive manner. That is, fewer events should be used until skill is developed. Each slide should be shown approximately three seconds. This forces students to identify and respond quickly. Also, training sessions of from 10-15 minutes are more effective than lengthy sessions. Below is an example of a classified traffic scene (Figure 4b).

The traffic scene should be scanned, looking for one category and then another: i.e., when looking over the traffic scene, the driver should look for all the traffic controls, then for the other traffic, then for the roadway features and, finally, for things inside the vehicle which might be important to driving in that situation. If the names of the classifications cause confusion, they can be changed. They are merely suggested names that have worked in the past. If you have better ones, use them. Of more significance is being able to quickly classify and decide the importance of events in the traffic scene.

APPLICATION TO INTERSECTIONS

Any technique is only as good as its application. The various perception techniques are easily applied to open road driving and are also important in the negotiation of intersections. As you approach an intersection, ask yourself if you have scanned well enough in advance to classify the traffic scene. Are any of the classifications changing as you get closer? Are you maintaining a sufficient following time? Is there anything new entering the scene? You must adapt these perception techniques to specific intersections. By doing this, you will be taking a considerable step towards safer driving.

II. Exercise Explanation

SERPENTINE

The serpentine course is not directly related to an emergency situation. However, it is included because it helps acquaint the student with the vehicle, and the controls stressed in the exercise are basic to many driving situations.

Purpose

The purpose of the serpentine exercise is to develop in a student a sense of control of the vehicle. The exercise assists the student in learning proper timing of steering inputs, coordination of throttle and steering, judging the relationship of fixed objects with respect to the vehicle, and familiarizes the driver with the 9-3 hand position.

Course Operation

The course consists of at least six cones placed in a straight line and evenly spaced. The student drives through the course, passing by each succeeding cone on the opposite side from the preceding one, as in a slalom course (Figure 5).

Correct Execution

The student approaches the line of cones in a straight line parallel to the cones at a speed indicated by the instructor. It should be between 15 and 25 mph, depending on cone spacing and skill of the student. The student should maintain that speed throughout the course.

The 9-3 hand position is used in the maneuvers. Most students are able to turn the steering wheel 180 degrees in either direction with their hands so located without taking them off the wheel. The course of the car should be as close to the cones as possible without striking them.

The student approaches the course in a straight line parallel to the cones. As the car passes the first cone, the student steers into the lane on the opposite side of the cones. He passes on alternate sides of the cones until the course is completed.

For a successful pass through the course, the student must maintain a constant speed, not strike a cone, keep hands at 9 and 3, stay close to the cones and, in general, control the vehicle in a smooth and consistent manner.

Driving Goals

- Negotiate the course smoothly.
- Keep right and left steering movements constant and even.
- Maintain 9-3 hand position, if physically possible.
- Maintain constant speed throughout the course.
- Pass very closely to cones with both sides of the car.
- Negotiate at least six cones without striking any.
- Develop confidence in having the ability to perform the maneuver.

Procedure

1. The instructor explains the purpose and demonstrates the maneuver.
2. The instructor emphasizes to the student throttle control, steering movements, and hand position.
3. The student assumes the proper driving position.
4. The student enters the course at a speed determined by the instructor.
5. The student drives through the course as smoothly as possible.
6. The student can turn around and run the course in the opposite direction.
7. The student can operate at increasing speeds until the instructor is satisfied with his performance.

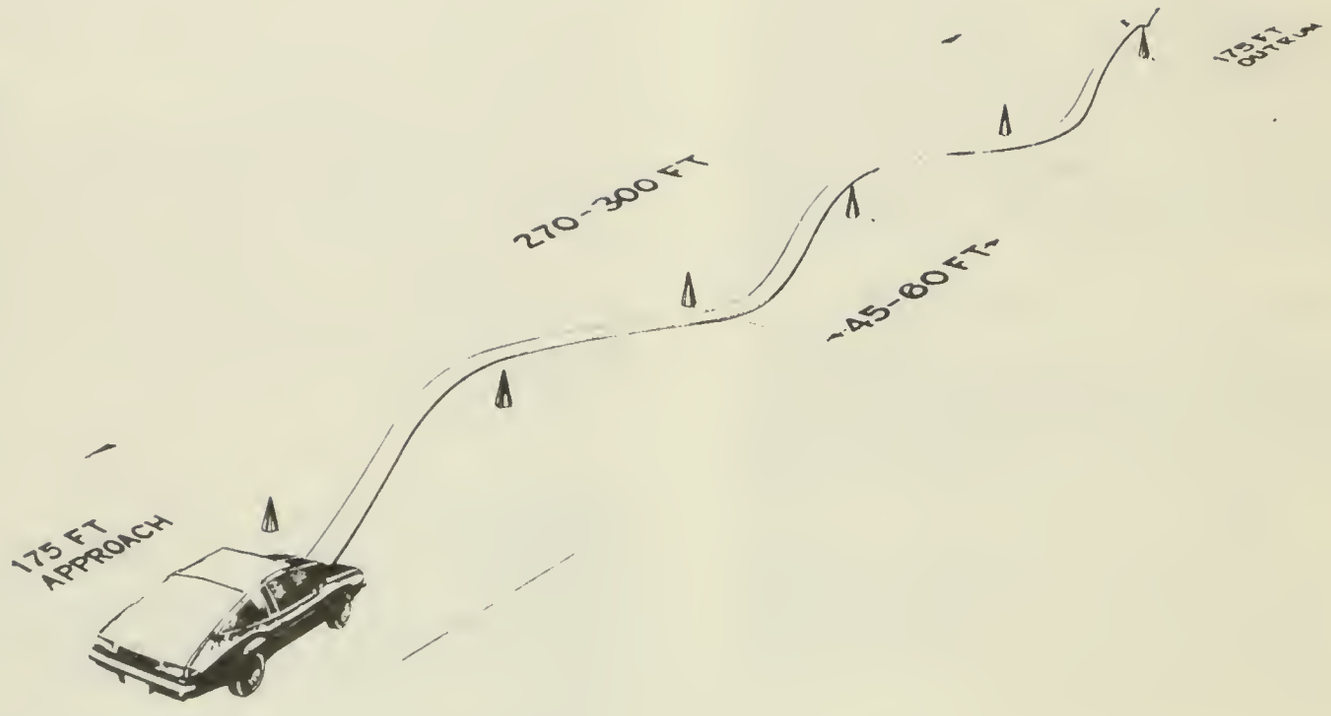


Figure 5—Serpentine Course

Instructor Tips

- The vehicle approaches the cones parallel to them and goes around the first cone as though it was in the middle of the course.
- Hand position remains at 9-3 throughout the course, if physically possible.
- Steering movements are smooth, continuous and even in both directions.
- Speed is lost at each cone due to cornering. Throttle pressure must be increased to maintain a constant speed.
- Stay close to the cones. The student may have to knock some down in order to learn how to position the vehicle relative to them.
- Staying close to the cones keeps the vehicle in as straight a line as possible. This minimizes steering movement which reduces the need to increase throttle pressure.
- Speed: For the first-time student, 15 mph is fast enough. Maximum speed will depend on the space available and safety considerations. However, it is not necessary to exceed 25 mph to accomplish the goals of this exercise.
- As speed is increased, it will be necessary to steer sooner as the vehicle approaches the cones.
- Watch the student carefully throughout the exercise. Inform him of what he is doing right and wrong and show or tell him how to make corrections.
- Correct the student's errors as they happen. It may be necessary to talk him through the exercise.
- Operational Checklist:
  - ✓ Entry speed
  - ✓ Hand position
  - ✓ Position of vehicle at beginning of course
  - ✓ Closeness of vehicle to cones
  - ✓ Smoothness of steering
  - ✓ Use of throttle
  - ✓ Exit speed

Common Errors

- Enters course too fast.
- Attacks the first cone at an angle rather than in a line parallel with the course.
- Fails to maintain speed and/or changes speed abruptly.
- Passes too far from the cones.
- Steering errors:

Does not steer enough to avoid cones with the front of the vehicle.

Steers too soon, striking the adjacent cone with the rear of the vehicle.

Does not steer continuously and strikes the next cone with the front of the vehicle.

EVASIVE

Many obstacles in the roadway which could be avoided are not. Because of lack of knowledge and/or skill, the driver may slam on the brakes instead of steering and possibly become part of the conflict. The evasive maneuver is designed to provide an alternative to panic braking in an emergency.

Purpose

The purpose of the evasive exercise is to illustrate that less distance is needed to steer a vehicle around an object than is required to stop before striking it. The exercise also serves to demonstrate the maneuvering capability and stability of the vehicle, as well as show the driver his capabilities and limitations in performing such a maneuver.

Course Operation

A lane of cones leads to a cone barrier. Exit lanes are located on either side of the barrier, parallel to the approach lane. The student drives down the approach lane and, on the cue of the instructor, evades the barrier by going right or left through an exit lane (Figure 6).

Correct Execution

The student enters the approach lane at the speed selected by the instructor (start at 25 mph) and maintains that speed. The instructor cues the student to go right or left. The proper response by the student is to release the throttle and, at the same time steer in the indicated direction around the barrier and into the exit lane. The brakes are not used.

The 9-3 hand position is used to execute the maneuver. There is no need for more than 180 degrees of steering.

A maneuver is considered a success when the student evades on cue, strikes no cones, maintains the 9-3 hand position, releases the throttle, and does not use the brakes. It is desirable, but not necessary, for the student to go in the direction called by the instructor. Doing everything else correctly is more important.

Driving Goals

- Maneuver the vehicle through the course on cue without striking cones.
- Develop an understanding of the steering movement (approximately 180 degrees) and timing necessary to make the maneuver.
- Understand that at high speed the vehicle can usually evade around an object in a shorter distance than would be required by a panic brake stop.
- Become familiar with lateral movements of a vehicle.
- Overcome any tendency to use the brake.
- Develop confidence in having the ability to control a vehicle in such a maneuver.

Procedure

1. The instructor explains the purpose and demonstrates the maneuver.
2. The instructor stresses importance of steering control, releasing the throttle, and not using the brake.
3. The student assumes the proper driving position.
4. The student enters the course at a speed determined by the instructor.
5. On the instructor's cue, the student steers toward the exit lane the instructor indicates, releases the throttle, and does not brake.
6. The student countersteers into the exit lane and maintains lane position.
7. The student drives to the start of the course.

OR

The student turns around to run the serpentine, set up along side evasive exercise.

Figure 6 – Evasive Maneuver

Instructor Tips

- The student may tend to guess the direction the instructor will call. It is more important to make the maneuver without striking cones than to go the called direction. If guessing is a problem to the extent that the student is not learning, it may be necessary to alter the procedure to meet the needs of the student.
- Watch the student carefully throughout the exercise. Inform him of what he is doing right and wrong, and show or tell him how to make corrections.
- Approaching the cue point, the student may tip off an unconscious intention toward one exit lane. Watch for shifting, leaning, or movement of a hand on the steering wheel, all in the intended direction. These cues can be used to make the exercise easier or more difficult according to the needs of the student.
- Have the student obtain the desired speed as quickly as possible and then hold the throttle steady. This will allow him to concentrate on the driving tasks.
- Speed: 25 mph to start. Increase speed in approximately 2.5 mph increments as student goes through course without striking cones. Increase the speed until the limit of capability of the student or course is reached.
- If a student strikes cones on two or three consecutive passes at the same speed, reduce speed to a level at which he can be successful, then build up again.
- Slight variations from the desired speed can be compensated for by adjusting the timing of the cue.
- Operational Checklist:
  - ✓ Hand position
  - ✓ Speed
  - ✓ Location of cue cone
  - ✓ Student's movements: hands, body, feet
  - ✓ Timing of steering
  - ✓ Cones struck
  - ✓ Release of throttle
- To help keep the student from guessing the direction, it may help to have him concentrate on a fixed point some distance beyond the barrier rather than on the barrier itself.
- Correct the student's errors as they happen. It may be necessary to talk him through the exercise.

Common Errors

- Steers in the wrong direction.
- Starts to steer in the wrong direction, then tries to recover.
- Steering movements are too slow.
- Does not release the throttle or applies more throttle.
- Improper hand position—hand(s) moves to different position on steering wheel or is taken off completely.
- Uses the brakes.

CONTROLLED BRAKING

Brakes are, of course, a very important means of controlling an automobile. However, when used to the point that the wheels are locked and sliding, as in a panic braking situation, another control is lost: steering. Many situations requiring the use of brakes are best handled if the brakes do not lock up the wheels, thereby maintaining the ability to steer.

Purpose

The purpose of the controlled braking exercise is to develop in the student the ability to achieve maximum braking while still being able to control the direction of the vehicle.

Course Operation

A lane defined by cones leads to a cone barrier. There is a left lane open around the barrier. The left lane is blocked 60 feet past the first barrier.

The student approaches the barrier and, on the cue of the instructor, brakes and, at the same time, steers to the left around the barrier. When past the first barrier, the student steers back into the right lane and stops (Figure 7).

Correct Execution

The student enters the approach lane at the speed indicated by the instructor (starting at 30 mph). When the cue is given, the student steers to the left very quickly to avoid the barrier, using the 9-3 hand position. At the same time, he brakes hard. If the student feels the vehicle sliding, he eases up on the brake pedal, but does not release it completely. When the vehicle is past the barrier, the student steers the vehicle into the right lane to avoid the left lane barrier and stops so that the vehicle is straight in the right lane. The vehicle should be stopped at or before the front is even with the left lane barrier. The student should maintain his foot on the brake pedal throughout the execution of the exercise.

The student is considered successful on a given pass when he does not anticipate the cue, maintains the 9-3 hand position, does not hit a cone, does not lock the wheels, returns the vehicle completely to the right lane, and stops before or even with the left lane barrier.

Figure 7—Controlled Braking

Driving Goals

- Maintain directional control of vehicle while braking.
- Sense loss of steering control due to braking.
- Develop the ability to ease brake pedal pressure when:
  1. loss of steering control is sensed; or
  2. the student recognizes that the situation calls for reduced braking in order to meet the anticipated steering requirements.
- Maintain control of the steering wheel.
- Develop confidence in having the ability to perform the maneuver.
- Negotiate the course without striking cones.
- Stop at or before reaching the second barrier.
- Stop with the vehicle in the right hand lane.

Procedure

1. The instructor explains the purpose and demonstrates the maneuver.
2. The instructor explains that a locked wheel can provide no steering control.
3. The instructor explains that, in this exercise, the student is to steer and brake at the same time.
4. The student assumes the proper driving position.
5. The student enters the course at a speed determined by the instructor.
6. On cue from the instructor, the student steers and brakes around the barrier.
7. The student eases off the brake pedal only as much as necessary to maintain directional control.
8. The student passes by the barrier and steers back into the right hand lane.
9. The student comes to a stop even with or before the second barrier.
10. The student proceeds to the beginning of the course.

Instructor Tips

- Controlled braking can be accomplished with either the right or left foot.
- Watch for foot and hand movements that are made before the cue is given.
- Speed: Range for effective teaching is 20-45 mph.
- Do not permit a left foot braker to cover the brake pedal with his left foot when that is not his normal highway driving habit.
- The cue distance can be shortened if the vehicle has not attained the desired speed at the normal cue point.
- Have the student attain the desired speed as quickly as possible and then hold the throttle steady.
- Watch the student throughout the maneuver. Inform him of what he is doing right and wrong, and show or tell him how to make corrections.
- It is important to reset the cones in the first barrier each time they are struck.
- Correct the student's errors as they happen. It may be necessary to talk him through the exercise.
- Point out that, in making a quick stop in a real situation, the driver needs to be aware of traffic behind him and not to block traffic unnecessarily by his braking action.
- Operational Checklist:
  - ✓ Speed
  - ✓ Hand position
  - ✓ Location of cue cone
  - ✓ Early foot movement
  - ✓ Early steering
  - ✓ Timing of steering and braking
  - ✓ Control of steering movement
  - ✓ Foot control while braking
  - ✓ Response of vehicle to steering and braking inputs
  - ✓ Cones struck

Common Errors

- Locks the wheels and does not ease off the brake pedal to let the wheels roll again.
- Does not brake soon enough.
- Does not steer soon enough.
- Anticipates the cue by moving a foot toward the brake pedal and/or by steering slightly.
- Forgets to brake, usually after having just completed the evasive exercise.
- Does not steer far enough to the left to miss the barrier.
- Does not coordinate braking and steering.
- Loses control of the steering wheel.
- Leaves vehicle partially in left lane when stopped.

SKID CONTROL

A skid is a vehicle-operating condition in which the driver has momentarily lost control of the vehicle. It implies that the vehicle has exceeded one or more tire-road traction limits. There are three basic forms of a skid.

1. **Braking Skid**: In this type of skid, steering control of the vehicle is lost because the wheels are locked. A braking skid generally occurs with all four wheels locked, but can also occur with one or more wheels locked.
2. **Cornering Skid**: This occurs when a driver attempts to negotiate a curve at a speed faster than can be sustained by the tire-road cornering traction limits, and the car slides.
3. **Power Skid**: When excessive power is applied, the drive wheels will spin and no longer provide cornering traction. Should this occur on a curve, the rear of the vehicle will slide to the outside of the curve. On a crowned road, the rear will slide down the crown even though the vehicle is following a straight path.

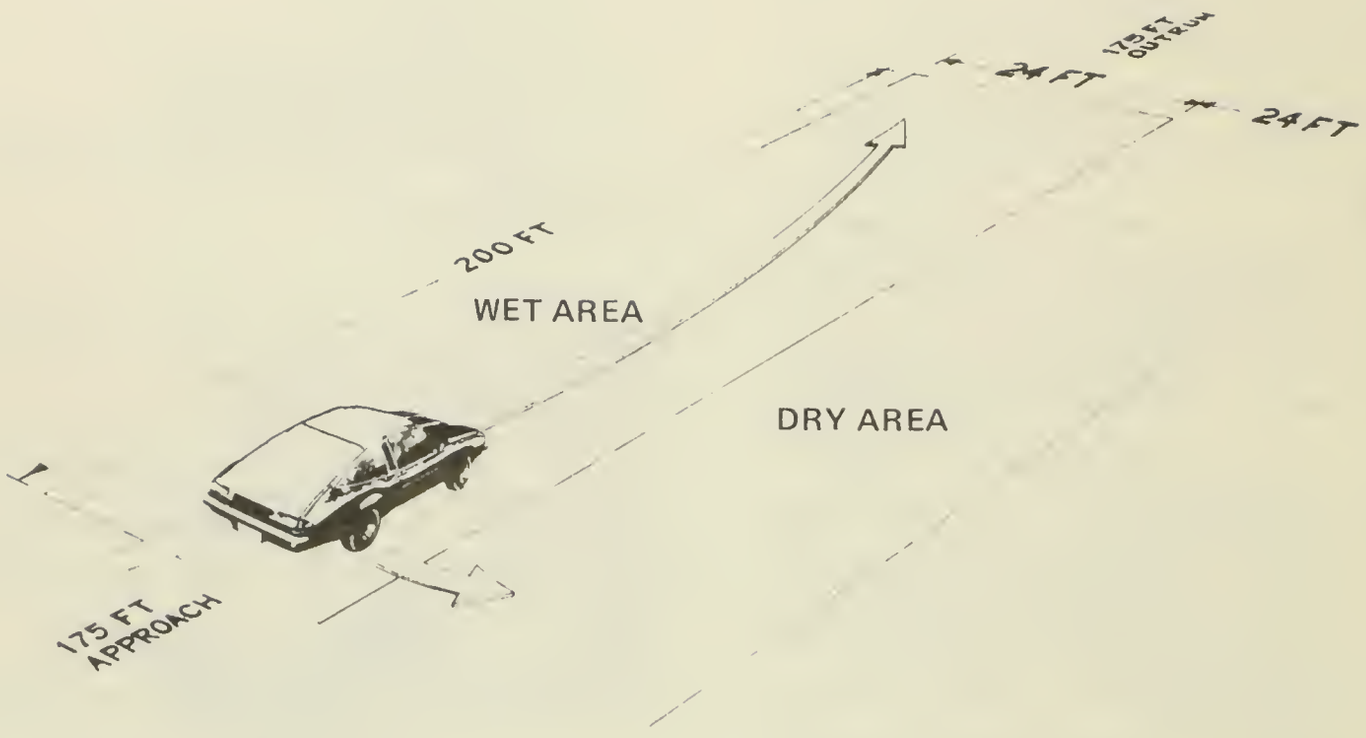


Figure 8—Skid Control Maneuver

The skid exercise simulates a power skid by momentarily locking the rear wheels rather than spinning them, since there is loss of ability to corner in either case. It is important for the student to understand that a power skid occurs because of over-application of the throttle. Therefore, not only is a steering correction necessary to correct the skid, but it is essential to reduce the throttle to stop the tires from spinning so they can regain cornering ability.

The ideal throttle positon is one that will maintain a "steady state" driving situation. This means the throttle is held steady so that the car neither accelerates nor decelerates. Therefore, the drive wheels turn at the same speed as the front wheels. However, this steady state condition is especially difficult to maintain on a slick surface. So, rather than attempt to maintain a steady state throttle position, it is best to release the throttle while making a skid recovery. Release of the throttle and corrective steering must be performed simultaneously.

It should be pointed out that the most effective means of handling a skid is not to have one in the first place. By being aware of the driving situations that produce skids and adjusting speed to match conditions, drivers can prevent many potential skids.

Purpose

The purpose of the skid control exercise is to teach the student to stop a skid and to regain directional control of the vehicle as soon as possible after a skid has been experienced.

Course Operation

The skid course is a slick area about 24 feet wide and at least 200 feet long. The student drives across the skid course following a curved path. The path may be marked by cones if necessary. With the car completely on the slick surface, somewhere along the curve the instructor initiates a skid for the student to control (Figure 8).

Correct Execution

The student follows a curved path across the slick surface at the speed indicated by the instructor. The speed should be between 15 and 25 mph, depending on the skill of the student.

When the student senses the skid, he eases off the throttle and, at the same time, turns the steering wheel in the direction the rear of the vehicle is moving. The brake is not used. The speed with which the steering wheel is turned should match the severity of the skid. Corrective steering is continued until the vehicle responds by not sliding further.

As soon as the vehicle responds to the steering correction, by not sliding further, the student returns the steering wheel to that position which will guide the vehicle in the desired direction. **The goal is to have the front wheels reach the position of pointing straight down the road at the same time the body of the vehicle is pointed straight down the road.**

After experiencing a skid and correcting it, there is the possibility of having a second skid linked with the first, but with the rear of the vehicle sliding in the opposite direction. The same technique used for controlling the first skid is applied to the second skid, or the third or fourth skids, should they happen.

The student is considered successful on a given pass if he steers in the direction the rear of the vehicle is moving, maintains firm control of the steering wheel, regains directional control of the vehicle, releases the throttle, and does not use the brake.

Driving Goals

- Regain directional control of the vehicle as quickly as possible.
- Gain experience in controlling multiple skids.
- Develop experience with the feel of a skidding vehicle.
- Develop judgment for the amount of steering needed to control skids of varying difficulty.
- Control skids using the recommended steering technique.
- Develop confidence in having the ability to perform the maneuver.

Procedure

1. The instructor explains the purpose of the exercise and makes sure the student knows the basic technique for controlling a skid. The instructor emphasizes that the student should:
   a. Steer in the direction the rear of the vehicle is moving.
   b. Ease off the throttle.
   c. Not use the brake.
   d. Be prepared for a second skid.
2. The instructor demonstrates the maneuver.
3. The student assumes the proper driving position.
4. The student enters the course at the speed determined by the instructor and follows the same path used in the demonstration.
5. When the vehicle is completely on the wetted skid surface and the student is driving in a curved path, the instructor initiates a skid.
6. The student controls the skid to the best of his ability by releasing the throttle, steering in the direction the rear of the vehicle is moving, and not using the brake.

Instructor Tips

- It is necessary to very closely observe the student's hand movements as he is correcting the skid. Inform him of what he is doing right and wrong, and show or tell him how to make corrections.
- Listen to the sound of the engine to determine if the student has released the throttle or has accelerated.
- Give the student simple, single skids at the start.
- Correct the student's errors as they happen. It may be necessary to talk him through the exercise.
- Make sure the student starts with the 9-3 hand position, but changes to the hand-over-hand method if necessary.
- Vary the exercise so that the student does not develop a conditioned response to the skid.
- Watch for foot movement to determine if the student has a tendency to use the brakes.
- Several factors determine how severe the student's skid will be: speed, the angle of entry of the vehicle onto the skid surface (the greater the angle, the more steering needed to stay on the skid surface and, therefore, the more severe the skid), and the length of time the instructor keeps the rear wheels locked.
- Speed: On a slick surface (coefficient of friction of about .10) skid control can be taught from 20 to 30 mph. Start at the lower speed and work up gradually as the skill of the student would indicate.
- Operational checklist:
  - ✓ Speed
  - ✓ Hand position
  - ✓ Amount of steering used to drive curved path
  - ✓ Angle of the path of the vehicle to the skid surface
  - ✓ Hand movement in correcting skid
  - ✓ Response time of the student
  - ✓ Timing of countersteering
  - ✓ Final hand position

Common Errors

- Responds slowly to the first skid, allowing the vehicle to go beyond the point of control.
- Does not steer enough to control the skid.
- Over-responds to the skid, by turning the steering wheel too much, possibly causing a second skid.
- Starts the countersteer too late after the initial correction.
- Does not use hand over hand steering if more than 180 degrees of steering is required.
- Holds the 9-3 hand position until 180 degrees of steering is achieved and then momentarily stops steering. This causes the student to be very slow in applying additional steering and may result in the vehicle skidding out of control
- Takes both hands off the steering wheel at the same time.
- Does not ease up on the accelerator.
- Tries to control the skid by using the accelerator or accelerates unknowingly.
- Applies the brakes, possibly locking the wheels.
- Cannot distinguish which direction the rear of the vehicle is skidding and does nothing.
- Steers in the wrong direction.

OFF-ROAD RECOVERY

Occasionally a vehicle may go off the edge of the road. There are many reasons for this to happen and it may come as a surprise to the driver to realize that both wheels on one side of his vehicle are off the road. When this happens, it is best to slow down and come back to the road when it is safe to do so. But, the driver's reaction to the situation and the surrounding circumstances may cause him to do something else.

Many people try to get back on the road as quickly as they can and without slowing down. This is a natural reaction. Also, the shoulder of the road may be blocked by a parked car, bridge abutment, etc., making a quick return to the roadway necessary to avoid a collision. However, the driver may steer too much and the vehicle may cross over its lane into the adjacent one or even off the other side of the road.

Another common response is to steer very cautiously to slowly bring the vehicle back onto the roadway. A serious problem can develop when there is a drop-off from the road pavement to the shoulder. Steering only slightly can cause the sidewall of the front tire to scrub against the edge of the pavement. When this happens,a great deal of steering is needed to force the tire onto the road. Because of this excessive steering, when the vehicle does come onto the road, it can cross over its lane into the adjacent one and possibly off the road on the other side before the driver can control it.

Purpose

The purpose of the off-road recovery exercise is to give the student an understanding of the problems involved in off-road recovery and to develop his skills in making an off-road recovery over a curb at operating speed.

Course Operation

The course consists of a road edge that has a drop-off and a line of cones to simulate a lane boundary. The student drives along the edge and drops two wheels over the edge. He then executes an off road recovery (Figure 9).

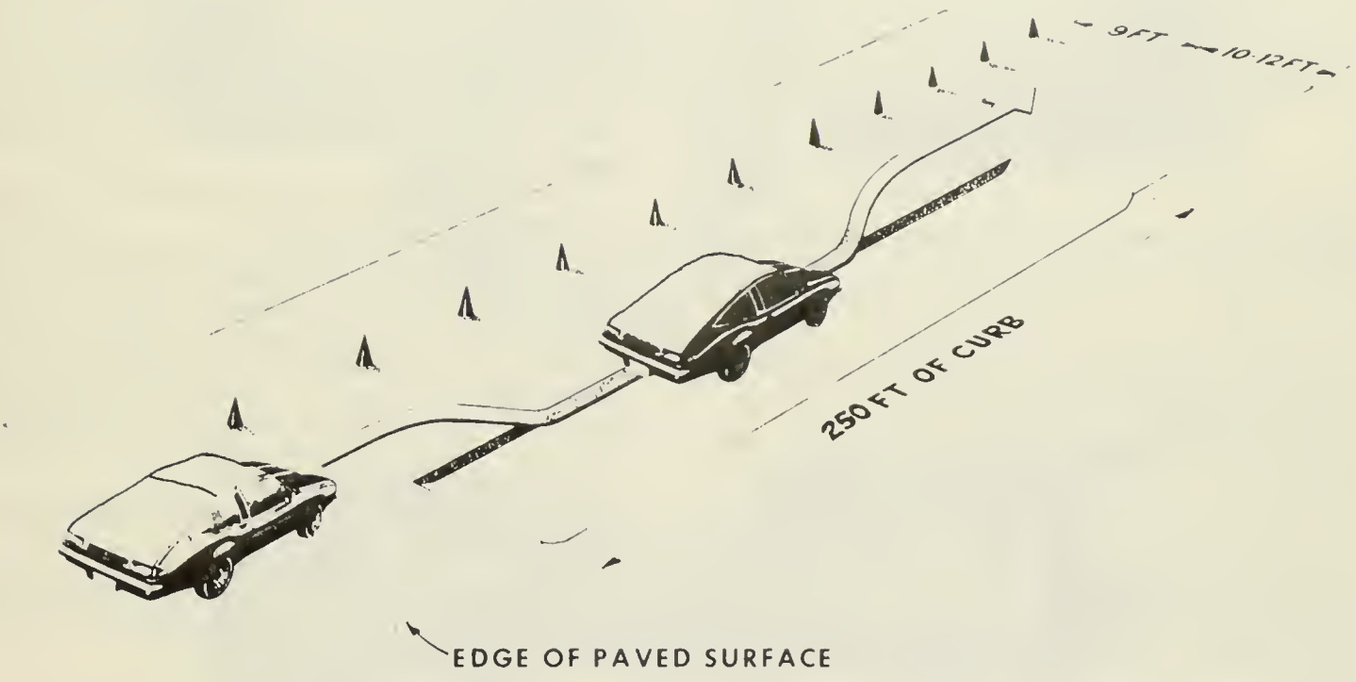


Figure 9—Off-Road Recovery

Correct Execution

The student approaches the off-road recovery curb at the speed indicated by the instructor (starting at 25 mph). With two wheels off the road edge, the student positions the vehicle so that the off-road wheels have room to turn without scrubbing the curb. Then he turns the steering wheel approximately one-quarter turn toward the road. When the student hears or feels the front tire hit the curb, he steers to straighten the vehicle so that it stays in its lane.

The student is considered successful on a given pass when he maintains the 9-3 hand position, steers no more than 90 degrees, counter-steers when the tire hits the curb, does not scrub a front or rear tire, maintains lane position without striking cones and maintains speed.

Driving Goals

- Recover the roadway at maximum speed allowed by the course.
- Upon recovery, maintain lane position in a 10 foot lane.
- Execute the recovery so that the tire tread rather than the sidewall contacts the curb.
- Maintain precise steering control.
- Develop confidence in having the ability to perform the maneuver.

Procedure

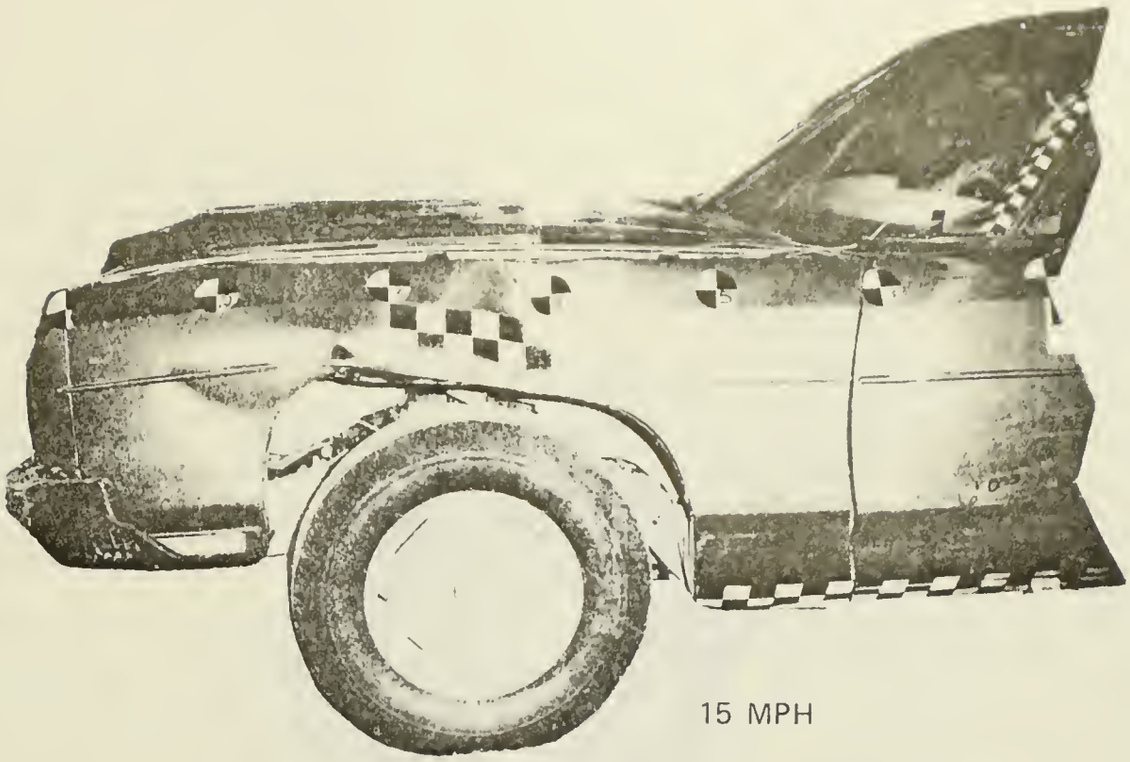
1. The instructor explains the purpose and demonstrates the maneuver.
2. The instructor makes sure the student knows that the first choice of action on leaving the roadway would be to slow down and return to the road at his discretion.
3. The student assumes the proper driving position.
4. The student enters the course at a speed determined by the instructor.
5. The student may either enter the course with the vehicle off the road or drop the wheels off the edge after the vehicle has reached the curb area.
6. The vehicle is positioned relative to the curb so that there is room for the front wheel to turn.
7. The student turns the steering wheel 45 to 90 degrees to bring the car back onto the road.
8. On hearing or feeling the front tire strike the curb, the student turns the steering wheel to maintain his lane position.
9. If the curb is sufficiently long, the student may make more than one recovery on a given pass.
10. After completing a pass, the student turns the vehicle around and makes a pass with the opposite side of the vehicle off the road edge.
11. As the skill level of the student increases, the instructor increases the speed up to the limit of the course.

Instructor Tips

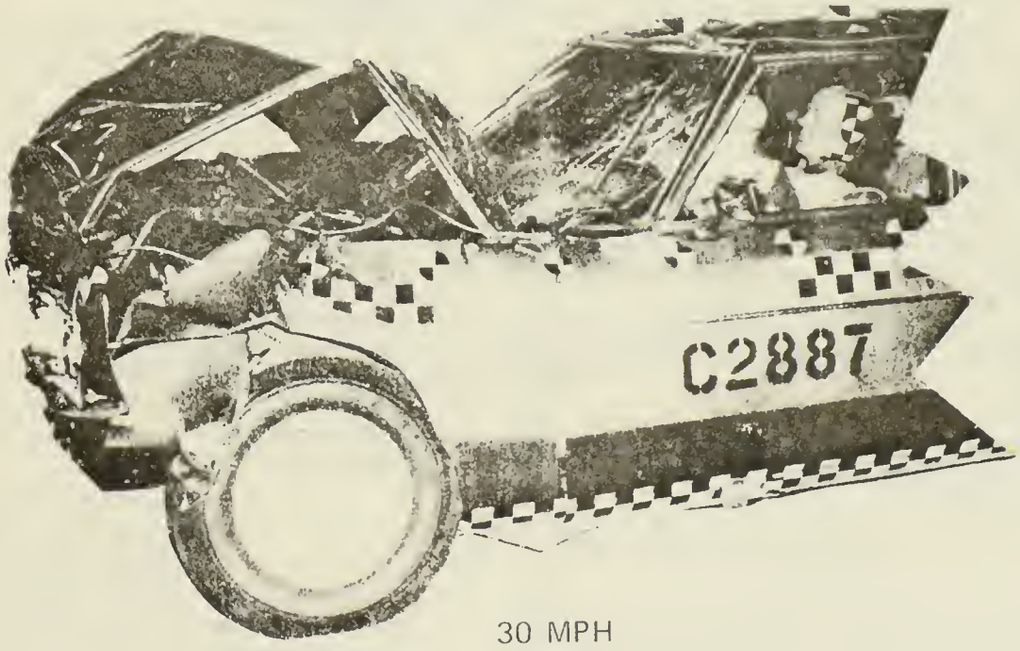
- Be sure to watch the student's steering motions closely to determine the amount and timing of his steering inputs. Inform him of what he is doing right and wrong, and show or tell him how to make corrections.
- Until the student is familiar with the exercise, he should be cued when to make the recovery. After that he can initiate the maneuver at his own discretion.
- Correct the student's errors as they happen. It may be necessary to talk him through the exercise.
- It is not necessary to center the vehicle over the road edge in order to give the tire enough space to turn. The shoulder may not be wide enough to do that. Just enough space is needed between the curb and the off-road tire for the tread, rather than the sidewall, to contact the curb when the recovery is made.
- 45 to 90 degrees of steering input is all that is needed to make a recovery.
- The greater the curb height and/or the closer the tire is to the curb, the greater the amount of steering and the quicker the steering wheel needs to be turned in order to recover the roadway.
- If the student turns the steering wheel to maintain lane position before the front tire strikes the curb, there is the possibility that the front tire will climb the curb and the rear tire will not. The rear tire can then scrub, causing a problem.
- The maneuver can be accomplished easily with the 9-3 hand position.
- Speed: Start at 20 mph. Increase in five mph steps as the student progresses until the limit of capability of the student or course is reached.
- Operational checklist:
  - ✓ Hand position
  - ✓ Timing of steering to maintain lane
  - ✓ Speed
  - ✓ Position of vehicle to curb
  - ✓ Amount of steering to recover road

Common Errors

- Does not allow sufficient space between the curb and the tire for the tire to assume the angle needed to come up over the curb without scrubbing.
- Steers too slowly. This can cause the tire to scrub, resulting in an improper recovery.
- Does not steer to maintain lane position when the off-road tire strikes the curb, or does so too slowly. The vehicle goes out of its lane as a result.
- Steers more than necessary to make the vehicle recover the roadway.



15 MPH



30 MPH

Figure 12—A 15 mph Barrier Crash vs.
A 30 mph Barrier Crash

III. Vehicle Dynamics

Vehicle dynamics is a complicated analytical and experimental technology that is used to study and understand the responses of a vechicle in various in-motion situations. In the driver education field, it is not necessary to deal with the specifics of this technology but rather with some of the basic physical principles involved in it. The principles discussed here will be kinetic energy, centrifugal force, inertia, and coefficient of friction. There is no intent to give a complete technical definition of each principle but to present them in a manner that will be useful in understanding why a vehicle acts as it does.

Kinetic Energy

Kinetic energy is the term that describes the energy a vehicle has due to its mass and speed. Its formula is simple, yet tells a great deal.

$$\text{Kinetic Energy} = \tfrac{1}{2} (\text{mass}) \times (\text{velocity})^2$$

This shows that the kinetic energy of the vehicle increases as the square of the velocity. This means that if speed is doubled, the energy increases four times. This energy increase causes no problem unless it must be dissipated or redirected quickly.

One way kinetic energy can be dissipated very quickly is when a vehicle strikes a solid object. In this case, when the speed is doubled, four times the energy is available to damage the vehicle and injure its passengers (Figure 12).

Also, kinetic energy can be dissipated rapidly by locked wheel or panic braking. In this instance, stopping distance is related to the square of velocity. Therefore, 30 mph requires four times the distance to stop of 15 mph.

Many drivers never think of the consequences of increased speed but they should be aware of the risks involved.

Centrifugal Force

When a vehicle turns, centrifugal force acts on the vehicle and tries to push it to the outside of the curve. The formual is:

$$\text{Centrifugal Force} = (\text{mass}) \times (\text{velocity})^2 / \text{radius of turn}$$

This shows that centrifugal force increases as the square of velocity. Also, at a given speed, small (tight) radius turns produce more force than large radius turns. Large amounts of centrifugal force require equally large amounts of counteracting force from the tires if the vehicle is to remain on the road. The tires can be thought of as strings from each end of the vehicle to the center of the turn. If the centrifugal force is higher than the tires can counteract, one or both of the strings break. The vehicle will then leave the turn.

Centrifugal force also causes body roll. Larger amounts of centrifugal force cause larger amounts of body roll which can be uncomfortable for the driver and passengers.

Inertia

The concept of inertia is not as easily understood as kinetic energy or centrifugal force. Inertia is the resistance to change the direction or velocity of a body, either at rest or in motion. In this case, it is related to changing the heading, or direction, of a vehicle, that is, changing from straight ahead driving to a turn.

Inertia is affected by both weight and the placement of that weight. A vehicle is designed and tested for a range of loading conditions that affect its inertia and the resulting weight distribution. Weight distribution change will also affect the steering characteristics. Gross changes in weight and weight distribution can seriously affect other parts of the vehicle also such as, brakes, tires and suspension components.

The importance of inertia and weight distribution as they relate to driving is that they affect the amount of time required to make a transition from straight to turning or vice versa. Although these changes with the usual loading of a vehicle are not large, a driver should recognize that an unusual loading of a vehicle, such as the placing of a large load on the tailgate of a station wagon (or the addition of a heavy load on the vehicle roof) will cause changes in the way his vehicle drives and he should adjust his driving accordingly.

Coefficient of Friction

The term coefficient of friction is defined as the maximum force that can be created by a tire on a given road surface condition, divided by the weight on the tire. Its formula is:

$$\text{Coefficient of friction } (\mu) = \frac{\text{Maximum Force Available}}{\text{Weight on the tire}}$$

Turning this statement around, the **maximum available force** is equal to the wheel load weight times the coefficient of friction (see Figure 13).

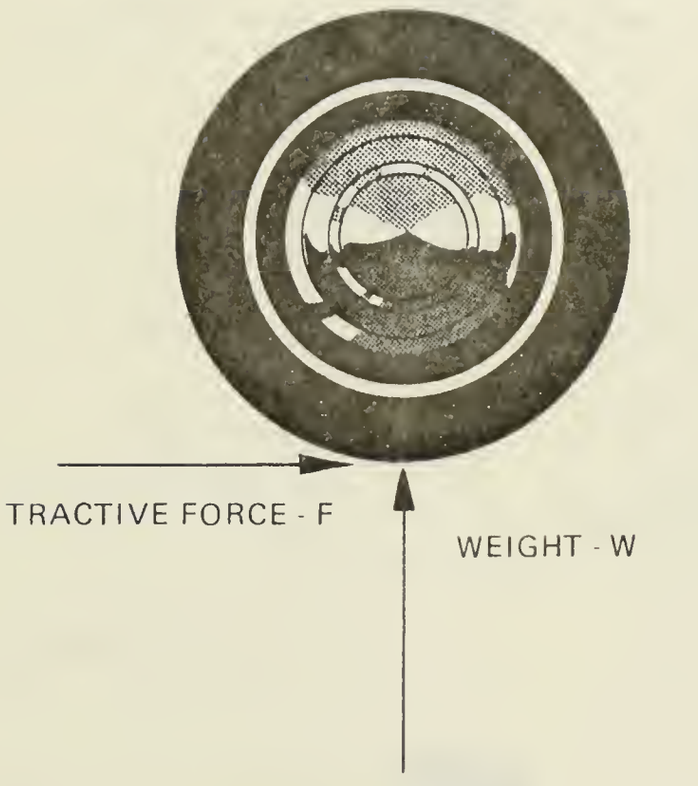


Figure 13—Coefficient of Friction

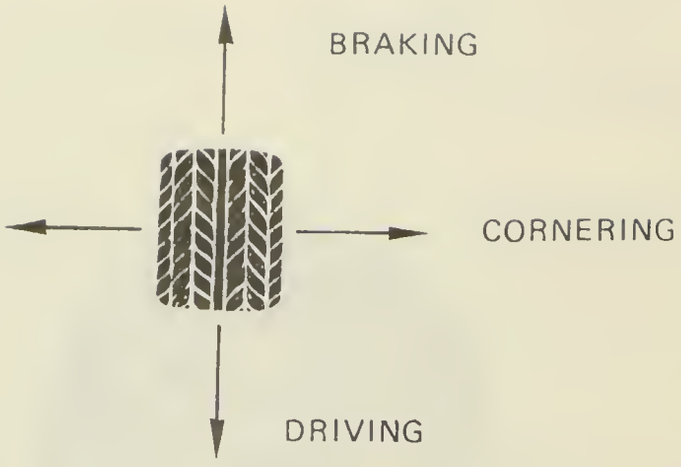


FIGURE 14

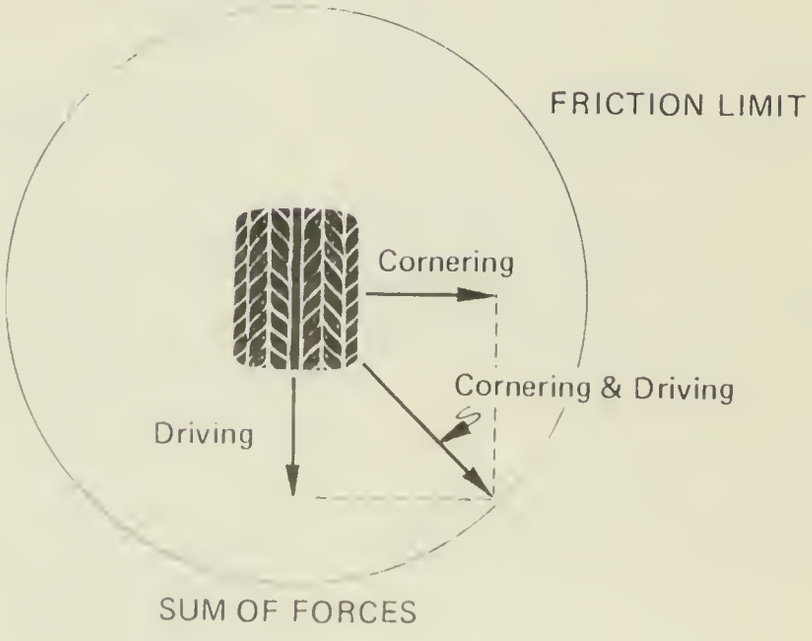


FIGURE 15

The traction forces available to stop, start, and corner the vehicle are dependent on the tire's construction, tread rubber compound and tread pattern, the road surface, and environmental conditions. The traction forces are limited by the coefficient of friction.

These traction forces can be defined as:

Driving Traction: The force of the tires pushing against the road to accelerate the vehicle forward.

Braking Traction: The force of the tires pushing against the road to slow or stop the vehicle.

Cornering Traction: The side forces developed by the tire pushing against the road allowing the car to overcome the centrifugal force as it goes around a corner or moves from one lane to another.

As can be seen from Figure 14, the three forces work in different directions. Since driving and braking forces work in opposite directions, they cannot exist at the same time. However, a cornering force can work in combination with either a braking or driving force.

The extension of this concept is that the combination of forces cannot exceed the limit of friction. Referring to Figure 15, we see that if we sum the arrows when we are demanding two traction forces, such as driving and cornering or braking and cornering, the two forces as arrows combined cannot exceed the friction limit.

The result of this phenomenon is that if we demand braking or driving forces while cornering, we lower the ability to produce a cornering force. In Figure 16, we can see that increased driving or braking traction causes a resultant loss in cornering traction. Driving and braking traction can be carried to the friction limit (Figure 17) so that the tire is either spinning or sliding and in so doing cannot provide a cornering force. This is an important concept: **A locked or spinning tire cannot produce a cornering force.** Also, **both front and rear tires must provide cornering forces for the driver to maintain directional control.**

Tread depth has a large effect on the coefficient of friction when the road surface is not clear and dry. The tread of a highway tire is designed to allow the tire to make contact with the road when the road is wet. Sipes wipe water to the grooves which collect the water and allow it to pass from beneath the tire as the tread contacts the road surface. A new tire has the deepest grooves and does the best job of eliminating water. When a tire is worn to the point that wear bars show up across the surface of the tread (Figure 18), there is about 1/16 inch of tread remaining, and its performance on a wet road is about the same as it if was bald. Thus, the tire cannot properly eliminate water and the coefficient of friction is significantly reduced. Even though there is some small amount of tread showing, the tire should be replaced.

All of the physical principles discussed here are taken into account when a vehicle is designed. This is accompanied by exhaustive testing to assure that a vehicle will respond predictably. If a vehicle is not maintained properly, or if it is significantly changed from its originally designed configuration, it may become less predictable in an emergency situation. This is an important reason for drivers to properly maintain their vehicle and refrain from making such changes.

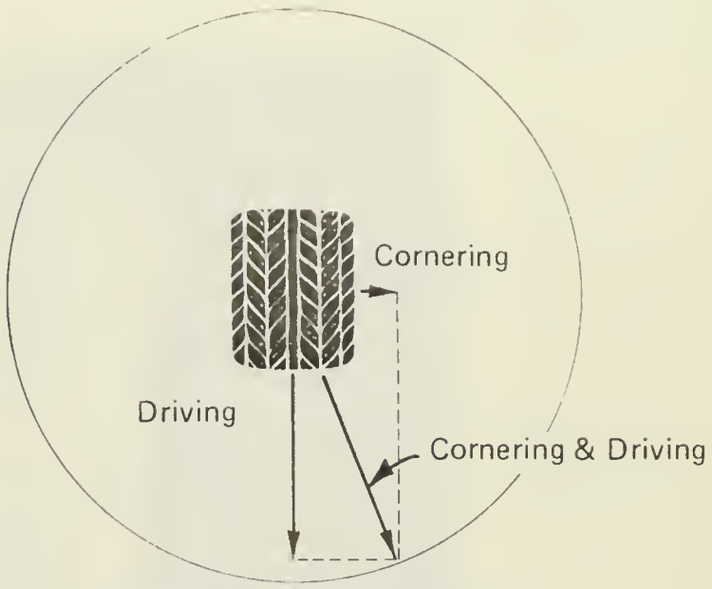


Figure 16—Increased Driving or Braking - Decreased Cornering

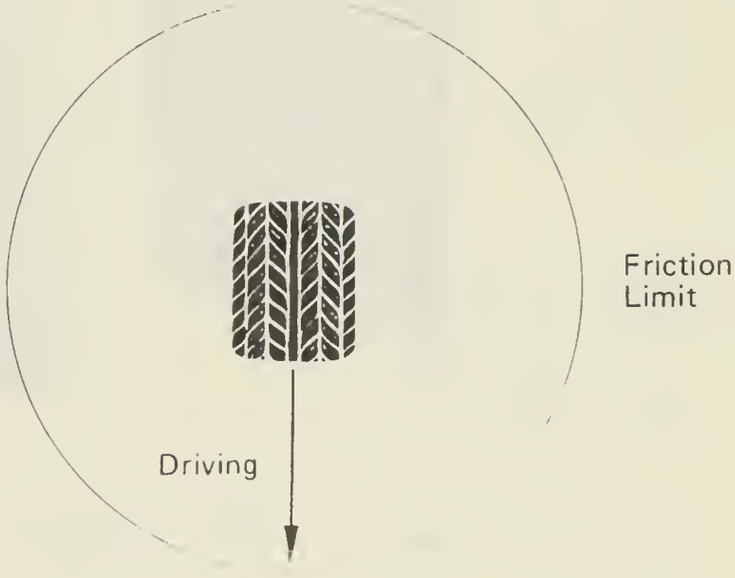


Figure 17—Locked or Spinning Wheel-No Cornering

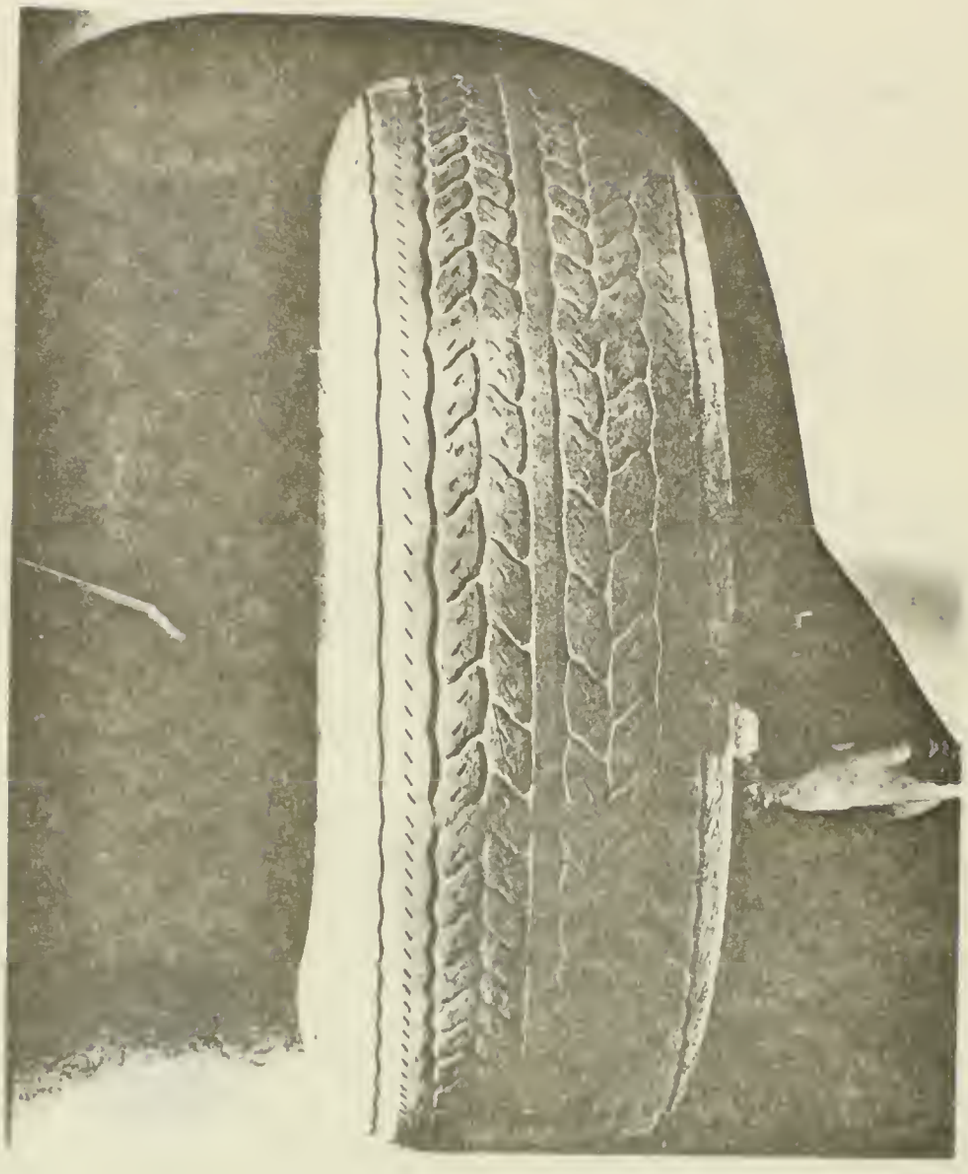


Figure 18 – Tire with Wear Indicator Showing

IV. Facility Layout

Each organization will probably choose or build a site to fit its own needs. A paved area 600 ft. by 600 ft. is adequate to run all of the exercises described in this publication at speeds of 25-30 mph. The area could include a skid pad of 24 ft. by 200 ft., an off-road recovery curb at least 250 ft. long, and sufficient space to run controlled braking, evasive and serpentine exercises (see Figure 19). Four vehicles could operate simultaneously with coordination.

You may wish to adapt the emergency driving exercises to an area already constructed. This may be a multi-vehicle driving range, airport runway, or a large parking lot. (Lewistown Layout, Appendix I.)

V. Design of Courses

Serpentine (Figure 5)

The serpentine course is a straight line of at least six cones spaced 45 to 60 feet apart, depending on the size of the area. The driver weaves through the course passing on alternate sides of the cones. A full lane of 12 feet should be available on either side of the cone course. One side of the approach lane of the evasive exercise can be used for this maneuver. If desirable, the serpentine exercise can be run in conjunction with the evasive exercise.

Evasive (Figure 6)

An approach lane 12 feet wide and about 250 feet long leads to a cone barrier across the lane. An opening of 60 feet is left between the last cone in the approach lane and the barrier. The last cone in the approach lane is used as the cue cone. Exit lanes 12 feet wide are located on either side of the barrier, parallel to the approach lane, and extended a distance of 50 feet beyond the barrier. The cones in the exit lanes should be about six feet apart.

The distances and speed may be reduced to make the course more challenging in smaller driving areas. The opening between the last cone in the entrance lane and the barrier can be reduced to 45 feet and the exit lanes narrowed to 10 feet.

Spacing of the cones in the approach lane is not critical unless the serpentine exercise is being used in conjunction with the evasive exercise. Then the cones should be placed to meet the requirements for the serpentine exercise. To make the serpentine long enough, at least six cones should be used on each side of the approach lane.

Controlled Braking (Figure 7)

A lane of cones 12 feet wide leads to a 12 foot barrier. Fifty feet before the barrier the lane opens to the left to form another 12 foot lane. The left hand lane extends beyond the barrier for 60 feet and ends in a barrier. The right side of the approach lane extends past the first barrier and ends even with the second barrier. A cue cone is placed along the right side 50 feet before the first barrier.

The spacing of the cones in the approach lane is not critical, but the cones marking the lanes around the barriers should be about 10 feet apart. By resetting a few cones on the evasive maneuver, that same area can be used for controlled braking.

Skid Control (Figure 8)

The skid pad should be 24 feet wide and 200 feet long. The surface is prepared by coating it with a coal-tar emulsion seal coat—the type used for driveways. Depending on the coarseness of the surface, several coats may be needed. Also, the sealer should be applied as smoothly as possible. A janitor's rubber squeegee will do an excellent job. A sunny day is best for application of the sealer. Several days should be allowed for the sealer to cure.

The skid pad should have an approach lane of at least 150 feet and an exit lane of 150 feet. This enables the instructor to run skids from both directions. Curves can be set up on the skid pad by using cones.

A water source is necessary in order to provide a coat of water on the skid surface at all times. This can be accomplished by using a water truck or a sprinkler system. The sprinkler system could either be built flush to the ground or set a safe distance from the skid pad so a vehicle will not run over the sprinkler heads. A clear buffer zone of at least 24 feet either side of the skid pad is needed. The skid area should be located so that the water will not drain onto the other driving areas. Do not wet the entire pad. If the entire pad is wet, the vehicle could skid off the pad, causing damage and/or injury. If the edges are left dy, the vehicle will remain on the pad.

Off-Road Recovery (Figure 9)

The length of the off-road recovery curb should be as long as space will allow. If 600 feet is available, 600 feet of curb is best. This will allow a maximum number of recoveries to be made on each pass. A hard surface 10 to 12 feet wide runs along the outside edge of the curb. This prevents ruts and holes from developing. A line of cones is placed 9 feet inside the curb and along its entire length. They are spaced six to 10 feet apart.

The design of the curb is important in order to teach off-road recovery correctly. It should be four inches high and vertical. The edge of the curb at road level should have as small a radius as possible, just enough to keep the edge from chipping easily (Figure 21).

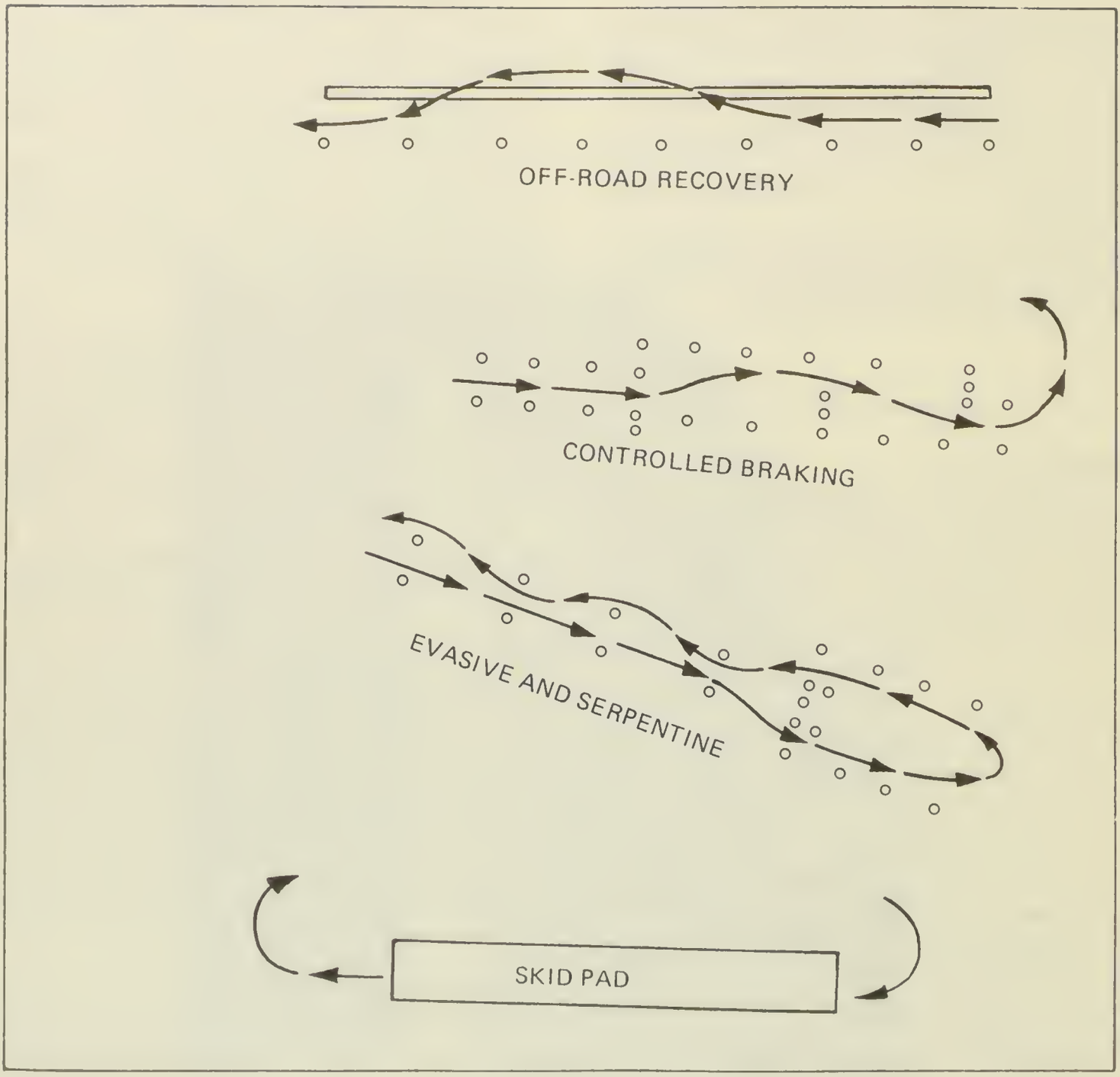


Figure 19 – 600' x 600' Driving Area

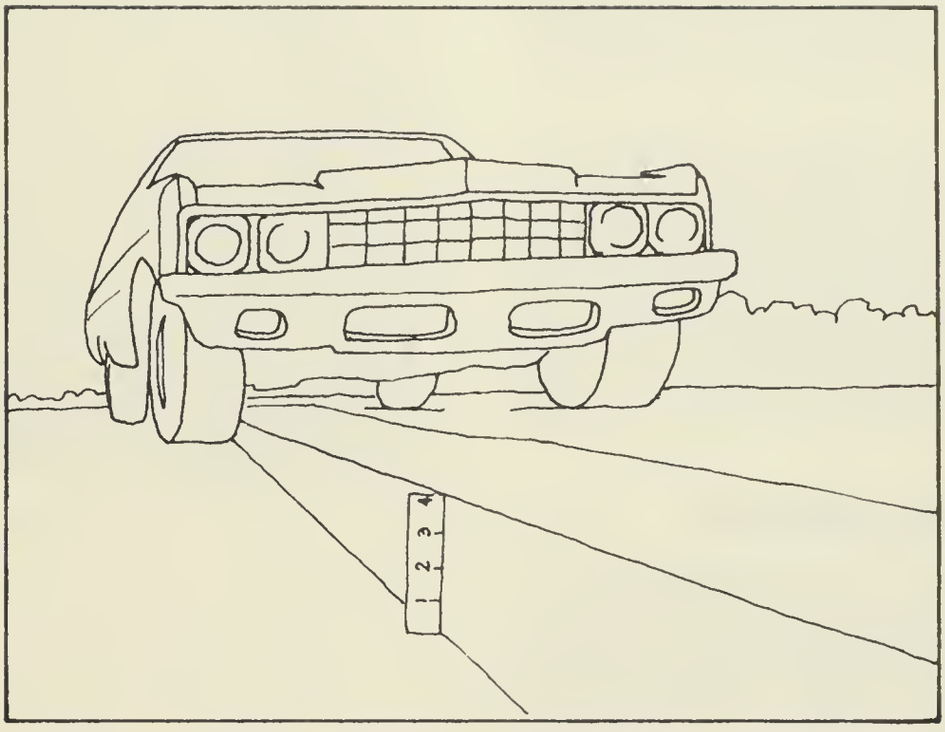


Figure 21—Off-Road Recovery Curb

VI. Safety Aspects

In selecting and operating a driving area, certain safety precautions must be observed:

- The area must be flat, free of dips or bumps, and have sufficient grade to allow water to run off the surface. A grade of 1 percent is ideal.
- The driving and surrounding areas must be free of curbing and obstacles.
- The driving area should be constructed of a high quality paving material, such as asphalt or concrete.
- A minimum of 50 feet between exercises should be maintained if more than one vehicle is operating in the area.
- Speeds must be adjusted to fit the size of the driving area and the number of vehicles accommodated. Most exercises can be run effectively at 25 mph.
- The instructor must have firm control over the actions of his student's vehicle at all times. This means seeing that the student operates at the proper speed and keeps the vehicle in its designated area.
- If at any time a student is driving without an instructor in the vehicle, some form of radio is needed for communication between the student driver and the range controller.

VII. Vehicle Preparation

The automobile used in an advanced driver training program must be in good condition and needs to be inspected and maintained on a regular basis. Daily inspection will be greatly aided by using a checklist, such as in Figure 22. When a deficiency is discovered, it should be noted and the problem resolved immediately.

More extensive inspection and maintenance should be done by a qualified mechanic. This schedule should follow the manufacturer's recommended procedures.

In addition to scheduled maintenance, any time a vehicle does not respond properly or there is any indication of a problem, it should be checked by a qualified mechanic.

The advanced driver training exercises need not be abusive to a well-maintained vehicle. Close cooperation between the instructor and the dealer will go far in eliminating problems and misunderstandings.

VIII. Special Equipment

Skid Car

The vehicle used for skids can be a standard size four-door passenger car equipped with standard tires. Tires worn to the wear indicators used on the rear of the vehicle will make it easier to create skids on a wet surface. It is recommended that skids be initiated in one of two ways:

1. By using a skid simulator; or
2. By using a separate brake pedal on the instructor's side that will lock the rear brakes through a mechanical connection with the emergency brake cable or through a hydraulic dual brake system. "Hydramite" Master Brake cylinders are used on our specially-equipped bus.

It is recommended that a scale drawing be made of the area to locate each exercise before starting the actual layout procedure. The exercises can be laid out with paint and traffic cones. The following minimum amount of equipment is recommended:

- 150 12-inch traffic cones.
- 100 foot tape measure or measuring wheel.
- Spray paint in various colors to code exercises.
- Numbers inside and outside the vehicle for identification by the student and controller.
- Communication system.

Figure 22— Daily Inspection Sheet

DAILY INSPECTION SHEET

Tires

- Tire Tread Depth _____ ☐
- Inflation Pressure _____ ☐
- Checks, Cracks, Cuts _____ ☐

Wheels

- Rim Damage _____ ☐
- Lug Nuts _____ ☐

Engine Compartment

- Oil Level _____ ☐
- Coolant Level _____ ☐
- Brake Fluid Level _____ ☐
- Battery Water Level _____ ☐
- Accessory Belts _____ ☐
- Power Steering Fluid Level _____ ☐

Driver and Passenger Compartment

- Brake Operation _____ ☐
- Steering System _____ ☐
- Restraint System _____ ☐
- Two-way Radio System _____ ☐
- Secure or Remove Loose Objects _____ ☐

Trunk Compartment

- Spare Tire and Jack Secured _____ ☐
- Special Equipment Secured on Skid Vehicle _____ ☐
- Secure or Remove Loose Objects _____ ☐

Check Fuel Level _____ ☐

Date Inspected: _____
Time Inspected: _____
Inspected by: _____

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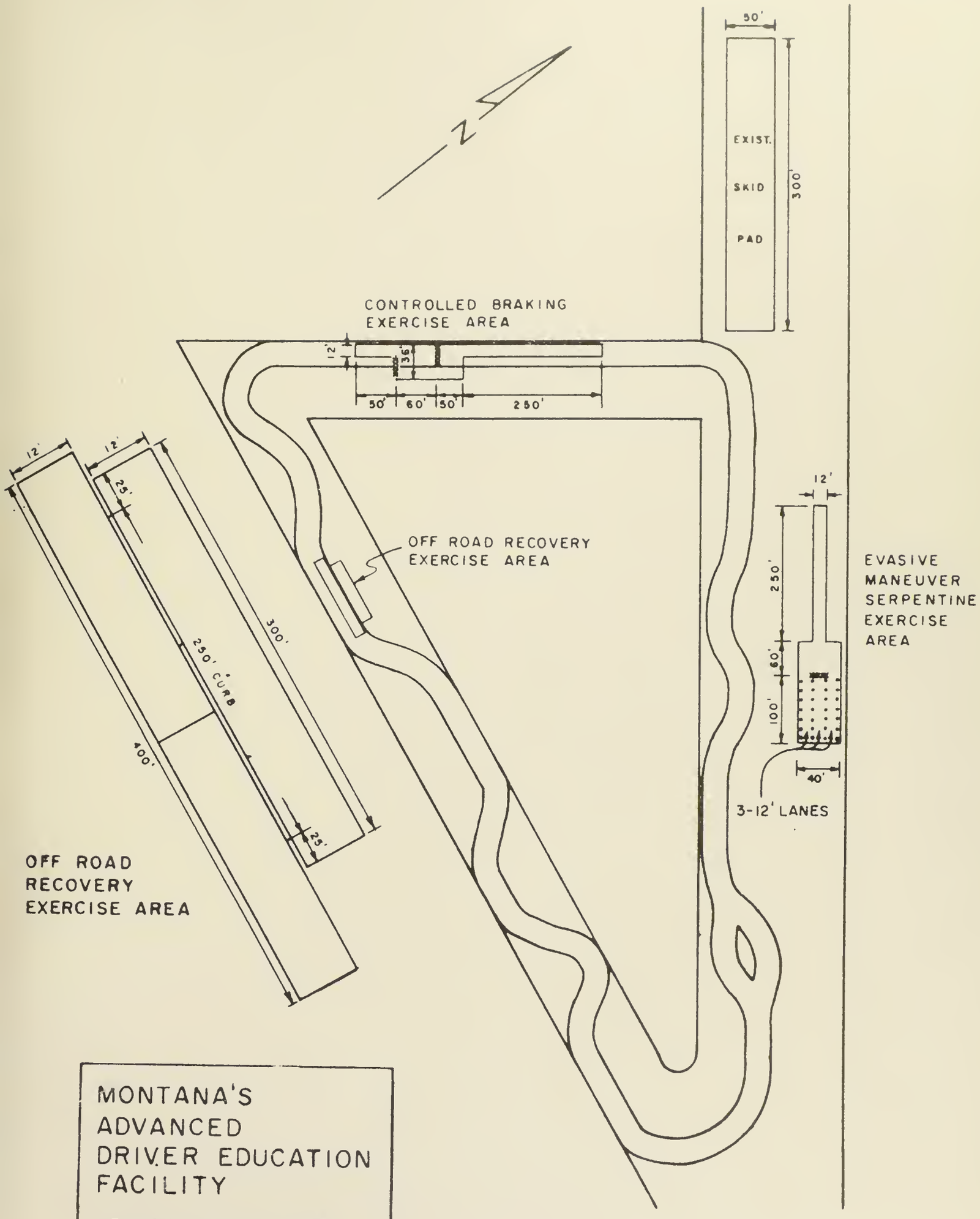

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